

TWR- 17541 Vol. VII  
ECS #: SS 01010

Flight Set 360L002 (STS-27)  
Field Joint Protection System Final Report  
Volume 7

June 1989

**Prepared for:**

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
GEORGE C. MARSHALL SPACE FLIGHT CENTER  
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812**

**Contract No.** NAS8-30490

**DR. No.** 3-5

**WBS No.** 4B601

## **MORTON THIOKOL, INC.**

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### **Space Division**

P.O. Box 524, Brigham City, Utah 84302 (801) 863-3511

(NASA-CR-183745-Vol-7) FLIGHT SET 360L002  
(STS-27) FIELD JOINT PROTECTION SYSTEM,  
VOLUME 7 Final Report (Morton Thiokol)  
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MORTON THIOKOL INC.

Aerospace Group

Space Operations


TWR-17541 VOL. VII  
FLIGHT SET 360L002 (STS-27)  
FIELD JOINT PROTECTION SYSTEM FINAL REPORT  
VOLUME 7  
FINAL REPORT

PREPARED BY:

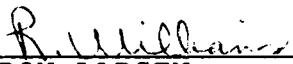
  
ELGIE HALE  
COMPONENT DESIGN

APPROVED BY:

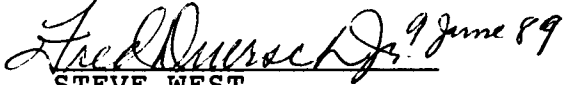
  
JOHN E. OOSTYEN, SUPERVISOR  
COMPONENT DESIGN SECTION

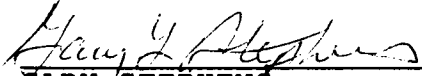
  
R.K. WILKS, MANAGER  
COMPONENTS

  
JAMES SEILER  
PROJECT ENGINEERING

  
RON LARSEN  
SAFETY

  
TED OLSEN  
CERTIFICATION PLANNING

  
STEVE WEST  
RELIABILITY

  
GARY STEPHENS  
PROGRAM MANAGER

  
RELEASE 6-19-89

REVISION \_\_\_\_\_

FORM TC 7994-310 (REV 2-88)

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**ACRONYMS**

JPS	Joint Protection System
RSRM	Redesigned Solid Rocket Motor
RTD	Resistance Temperature Device

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**ABSTRACT**

This report contains the pre-launch functioning data of the Field Joint Protection System (JPS) used on STS-27. Also included is the post flight condition of the JPS components following the launch and recovery of the two RSRM boosters. The JPS components are:

1. Field Joint Heaters
2. Field Joint Sensors
3. Field Joint Moisture Seal
4. Moisture Seal Kevlar Retaining Straps
5. Field Joint External Insulation
6. Vent valve
7. Power Cables
8. Igniter Heater

**1.0 INTRODUCTION**

Space Transportation System (STS)-27 was launched from KSC pad 39B on 2 December 1988. Two of the Redesigned Solid Rocket Motors (RSRM) were part of the launch system and are designated by RSRM-2A and RSRM-2B. The three field joints of both motors (total of 6 field joints) were protected by the Joint Protection Systems (JPS). See Figure 1. The igniter heater was mounted on the ignitor flange. See figure 2. The heaters were turned on at L-24 hours to assure the joint o-ring and igniter seal temperatures were within the launch commit temperatures at the time of RSRM ignition. The purpose of the moisture seal is to prevent entry of rain into the joint while on the pad. The cork insulation provides thermal protection for the JPS during flight.

Following booster separation and splashdown, the motors were recovered and taken to hanger AF for inspection and disassembly. This inspection was performed per Post Flight Engineering and Evaluation Plan (PEEP) TWR-16475, Vol. VII which outlines the basic evaluations to be performed at KSC Hanger AF.

**2.0 OBJECTIVES**

The objective of this report is to document the performance of the JPS and igniter heaters on the pad and the post flight condition of the JPS components. This document will also discuss all observations which were written up as Squawks and/or Problem Reports (PR's).

The following objectives of TWR-18891 are addressed in this report: (Numbers in parenthesis identify CEI specification paragraphs).

- J. Certify the performance of the field joint heater and sensor assembly so it maintains the case field joint at 75° F minimum. Field joints shall not exceed 120° F (3.2.1.11.a).
- K. Certify the performance of the igniter heater so it maintains the igniter gasket rubber seals between 75° and 120° F during and after the motor has been exposed to the ground thermal environments (3.2.1.5.3).
- L. Certify that each field joint heater assembly meets all performance requirements (3.2.1.11.1.2)

### 3.0 CONCLUSIONS AND RECOMMENDATIONS

The JPS heaters performed per specification and maintained the field joint temperatures within the required temperature range at the time of motor ignition (3.2.1.11.a).

The igniter heater performed per specification and maintained the igniter seals within the required temperature range (3.2.1.5.3).

All field joint heater assemblies met all of the performance requirements (3.2.1.11.1.2).

The component design team identified two conditions in which the JPS components failed to meet the design goals.

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1. The moisture seals of five of the six field joints were found to contain sea water. Three of the twelve vent valves in the moisture seals were open to air flow in both directions. The vent valves may have provided the path for sea water to enter the joints on splash down.
2. A 3.0 x 3.0 inch void was found in the cork insulation of the right center field joint. This had apparently occurred on splash down.
3. The igniter heaters were charred in two places where instrumentation wiring was improperly run between the heater and igniter adapter.

#### 4.0 RESULTS/DISCUSSIONS

##### 4.1 Heater Control System

The KSC heater temperature control system operated with a control band of 2°F (set point temperature  $\pm 1^\circ$ ). The four temperature sensors at each field joint were continuously monitored and the coldest sensor was automatically selected for temperature control. The switching logic was improved over the flight one logic and switching to a different sensor for control did not turn on the heater unless the sensor temperature was more than 1° below the set temperature.

## 4.2 Post Flight Inspection of the Joint Protection System

Evaluations of the JPS indicated the system performed as designed during flight. The only unexpected observation was the piece of missing cork on the right center field joint.

### 4.2.1 Moisture Seal

The water discovered in the field joints is believed to have entered by way of one or all of the one-way vent valves located at each joint. Some of the valves were found to be impaired when they were removed from the joint protection system.

A test of the vent valves on STS-27 was conducted in the VAB after assembly which verified that all vent valves were closed. This confirms that the vent valves were closed and prevented entry of rain water into the field joint while on the pad.

Tables 1 through 6 are the evaluation check off worksheets for the moisture seals and cork thermal shields.

### 4.2.2 Cork External Insulation

All of the cork and ablative compound on the field joints was intact and appeared well bonded except the 3 inch by 3 inch piece on the right center joint. Occasional pitting of the cork and paint was observed on those aft



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surfaces of cork that were exposed to nozzle severance and splashdown debris. Areas of darkened paint accompanied with blisters were also observed.

A piece of cork (3 x 3 inches) was missing on the right hand center field joint due to the cork not being bonded to the moisture seal. The total void of this region was measured to be 15 inches in length. Due to the heated condition of the cork surrounding the hole, the piece was probably lost during late re-entry. Figure 3 is a photograph of this void.

Tables 7 through 12 are the post test evaluation check off worksheets for the cork external insulation on the six field joints.

#### 4.2.3 Heaters and Sensors

The heater and sensor assemblies were not available for inspection except as shredded pieces after removal by water laser. The pieces looked at showed no signs of overheating, discoloration, or delamination.

Figures 4 through 6 are plots of the temperature of the four RTD's of each of the three field joints of the left SRM and figures 7 through 9 are plot of the RTD's of the right SRM. The ambient temperature is overlaid on the temperature plots.

#### 4.2.4 Heater Power and Sensor Cables

All of the cables of the JPS system were found to be in excellent condition. There was no evidence of voids or missing material, debonds, charred material, or impact damage. Tables 13 and 14 are the post test evaluation worksheets for the heater cables.

#### 4.2.5 Igniter Heater

The igniter heater installation on each motor was intact and secure. Both heaters were charred in two places where instrumentation wiring was improperly run between the heater and igniter adapter. The adjacent cork and painted igniter adapter also showed evidence of heat effect. Figures 10 and 11 are the plots of the temperature at the igniter adapter. Tables 15 and 16 are the evaluation checkoff worksheets for the igniter heater installation. Tables 17 and 18 are the evaluation checkoff worksheets for the igniter heater components.

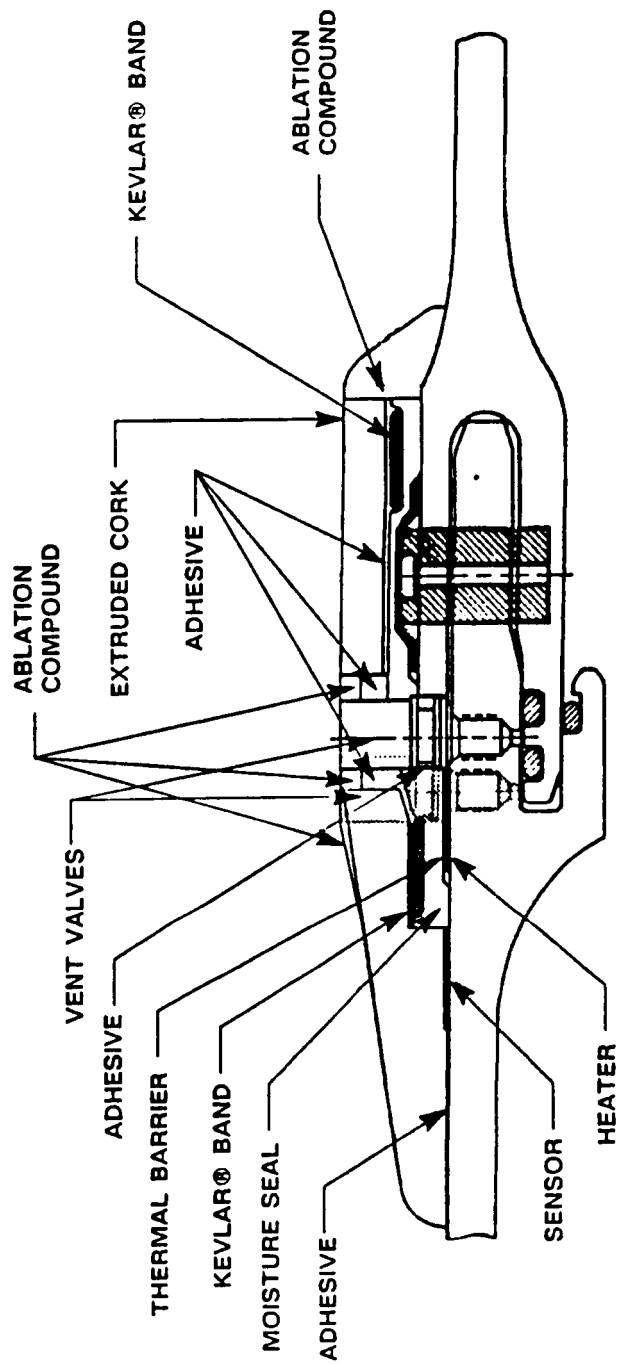


FIGURE 1

# IGNITER HEATER

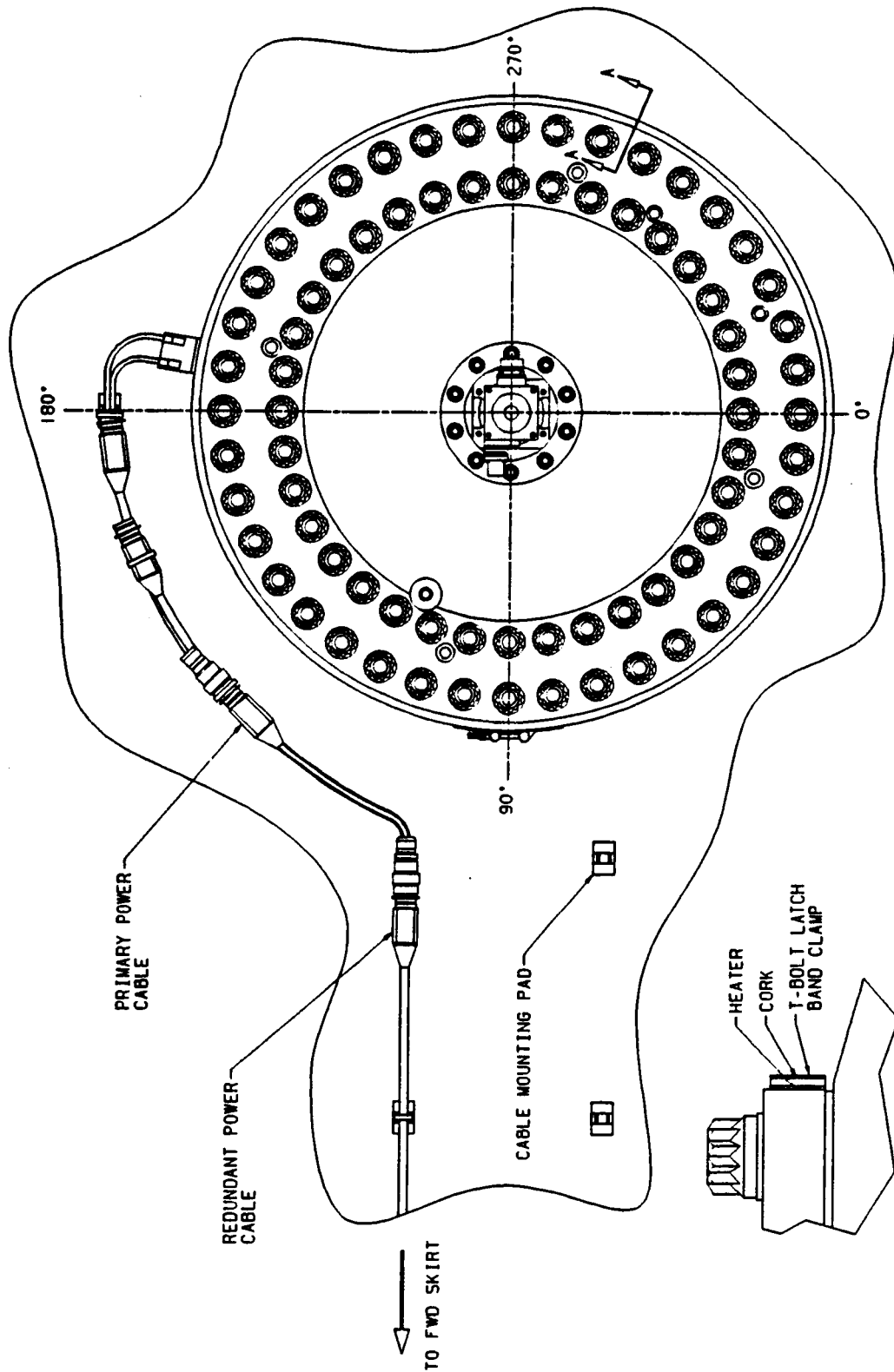
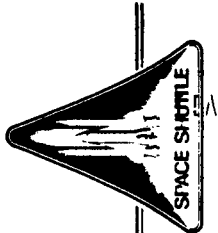


FIGURE 2

SECTION A-A  
ROTATED CCW 32°

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INFORMATION ON THIS PAGE WAS PREPARED TO SUPPORT AN ORAL PRESENTATION  
AND CANNOT BE CONSIDERED COMPLETE WITHOUT THE ORAL DISCUSSION

ORIGINAL PAGE  
BLACK AND WHITE PHOTOGRAPH



Figure 3

# 360L002 STS-27 PRELAUNCH LEFT SRM FWD FIELD JOINT TEMPERATURE OVERLAID WITH AMBIENT ZERO REF: 11 PM EST (KSC) 27-NOV-1988

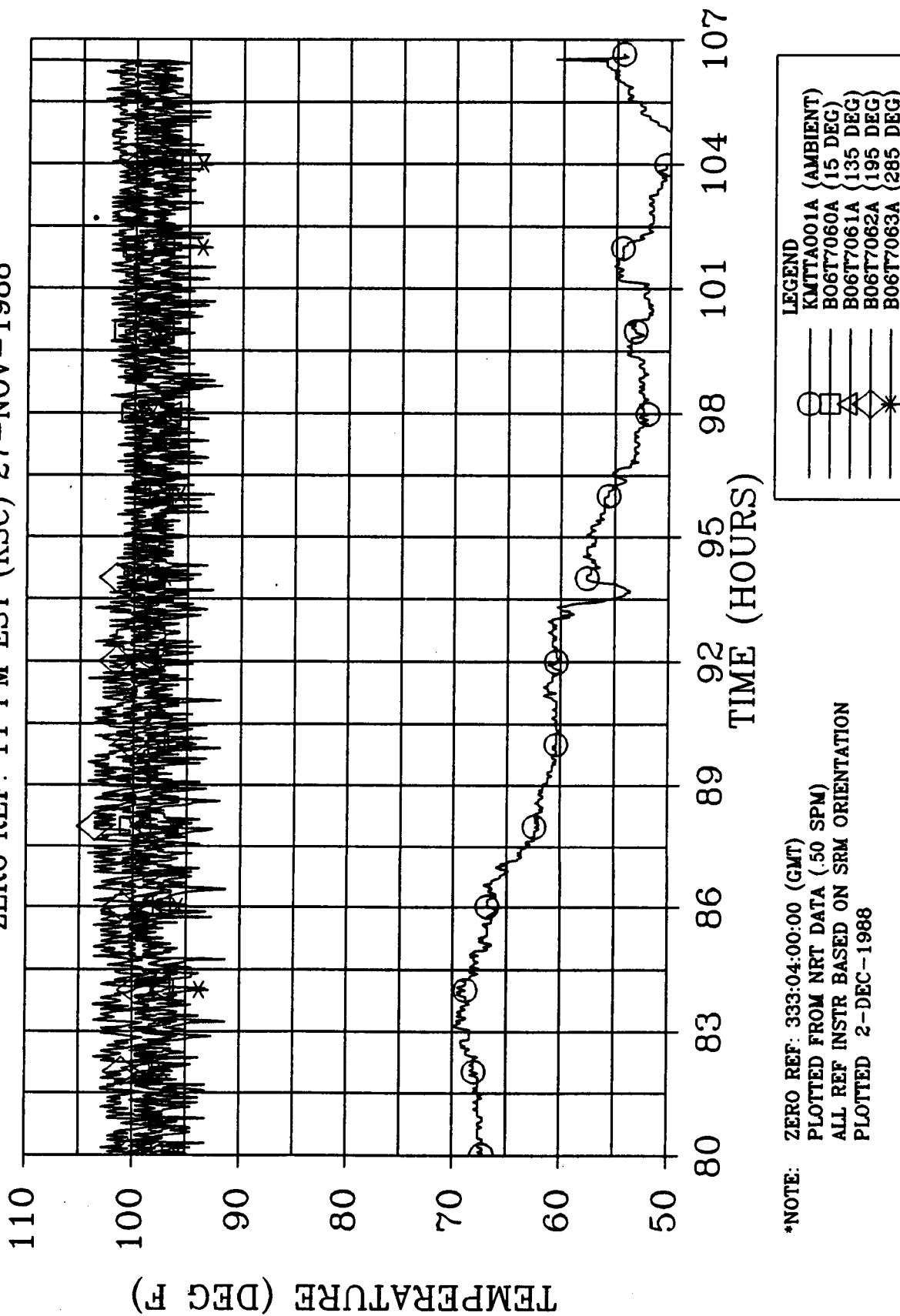


Figure 4

# 360L002 STS-27 PRELAUNCH RIGHT SRM FWD FIELD JOINT TEMPERATURE OVERLAID WITH AMBIENT ZERO REF: 11 PM EST (KSC) 27-NOV-1988

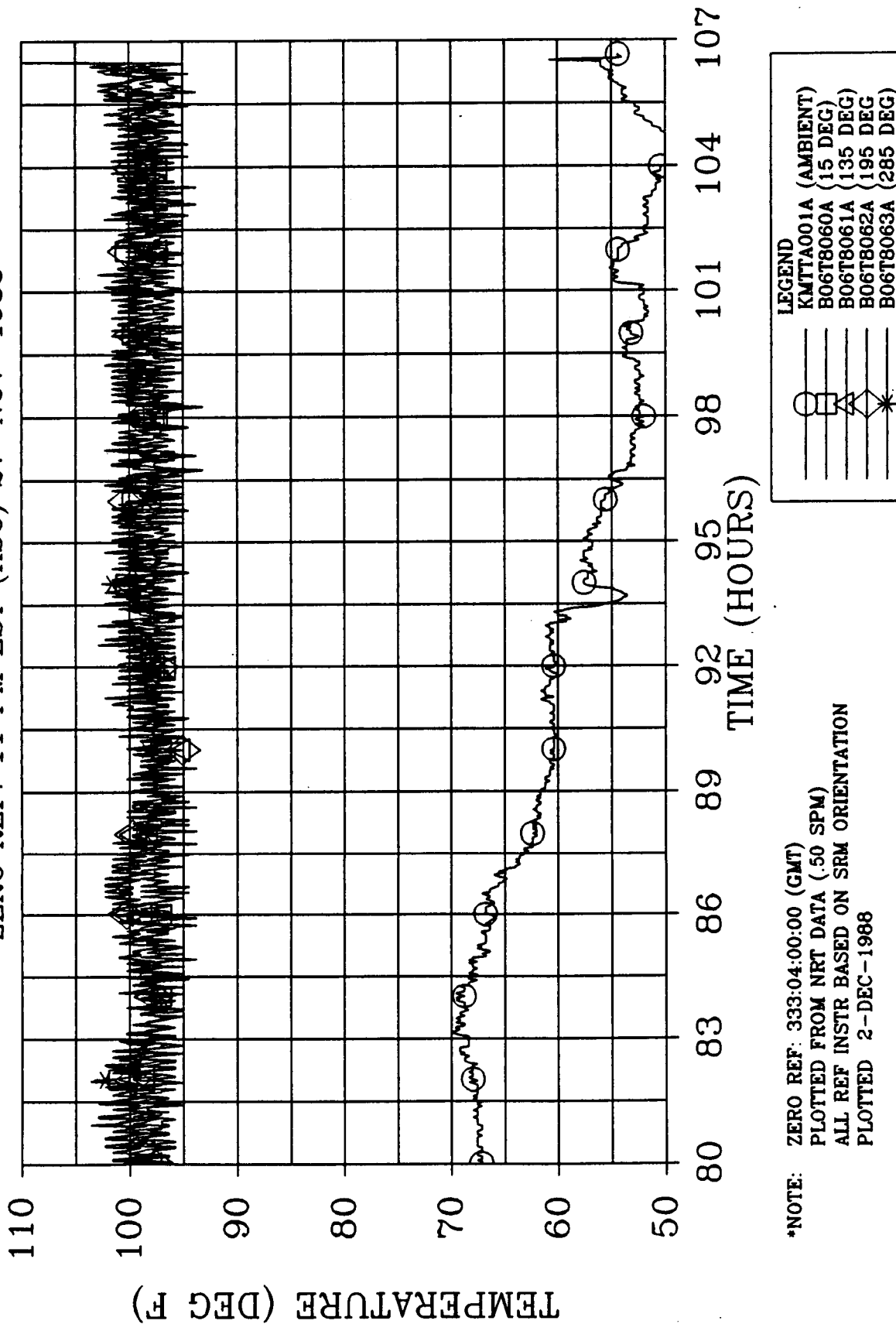
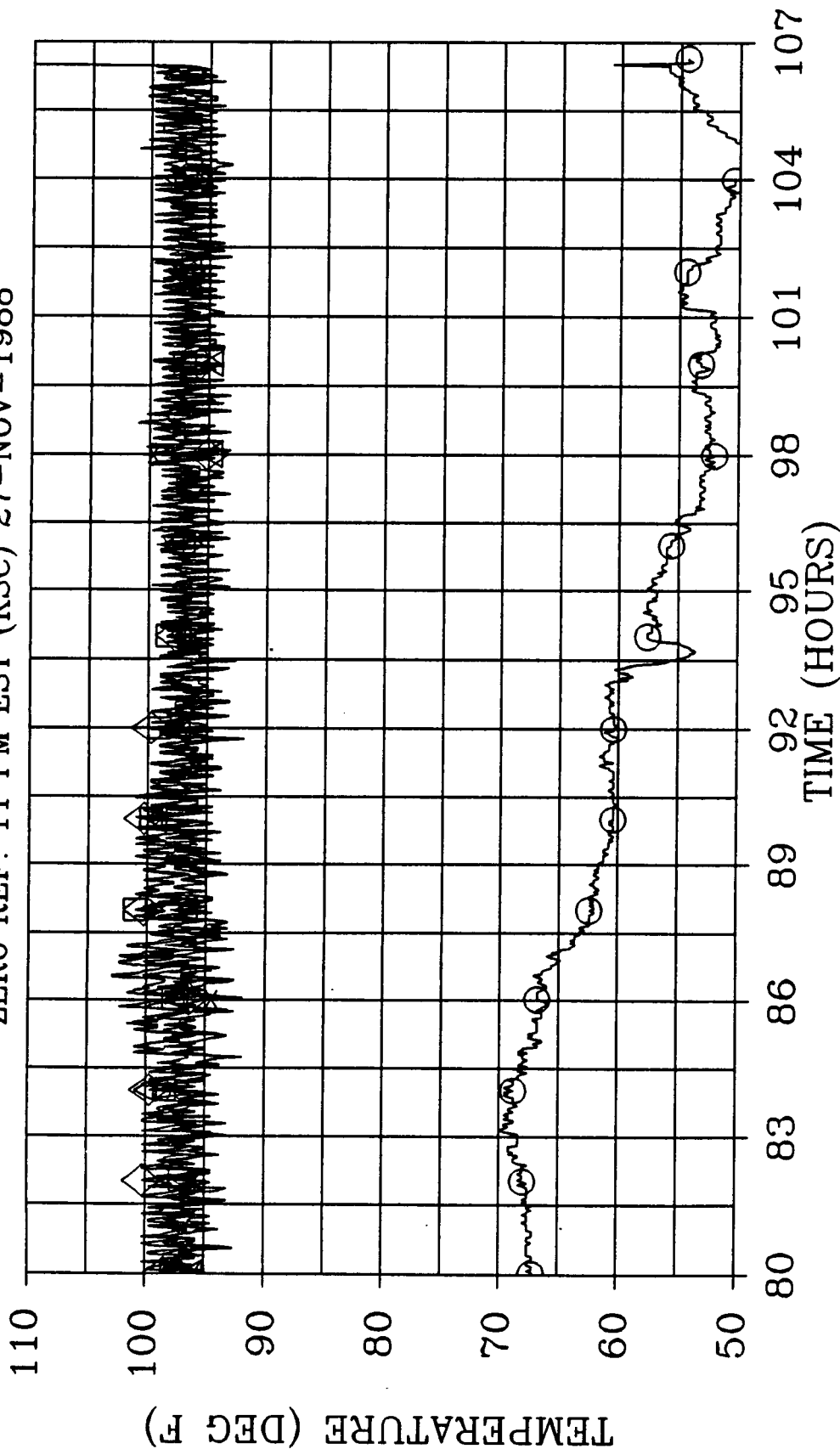


Figure 5

# 360L002 STS-27 PRELAUNCH LEFT SRM CNTR FIELD JOINT TEMPERATURE OVERLAID WITH AMBIENT ZERO REF: 11 PM EST (KSC) 27-NOV-1988



\*NOTE: ZERO REF: 333:04:00:00 (GMT)  
PLOTTED FROM NRT DATA (.50 SPM)  
ALL REF INSTR BASED ON SRM ORIENTATION  
PLOTTED 2-DEC-1988

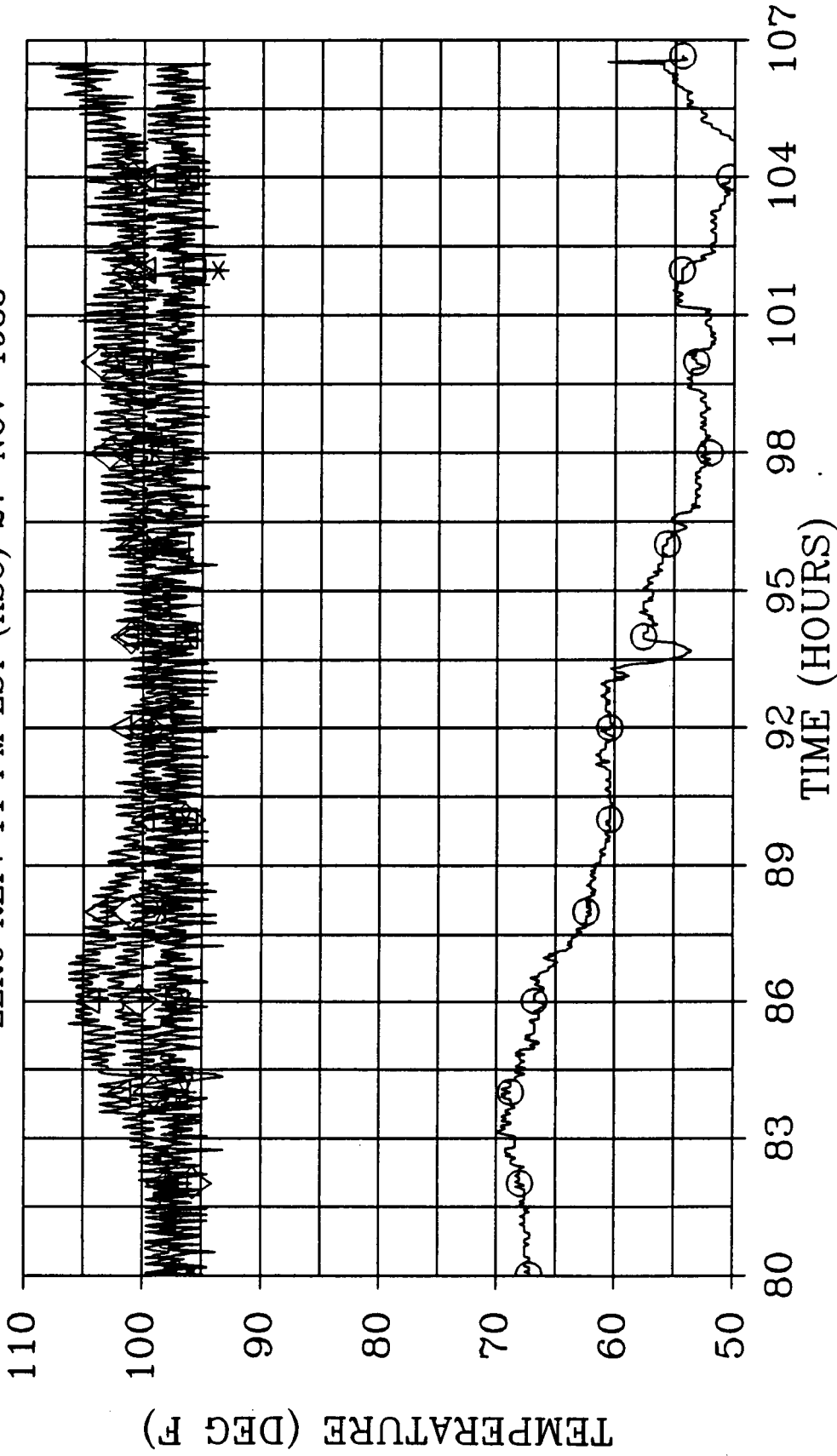
LEGEND	
	KMTT001A (AMBIENT)
	B06T7064A (15 DEG)
	B06T7065A (135 DEG)
	B06T7066A (195 DEG)
	B06T7067A (285 DEG)

Figure 6



# 360L002 STS-27 PRELAUNCH RIGHT SRM CNTR FIELD JOINT TEMPERATURE OVERLAID WITH AMBIENT

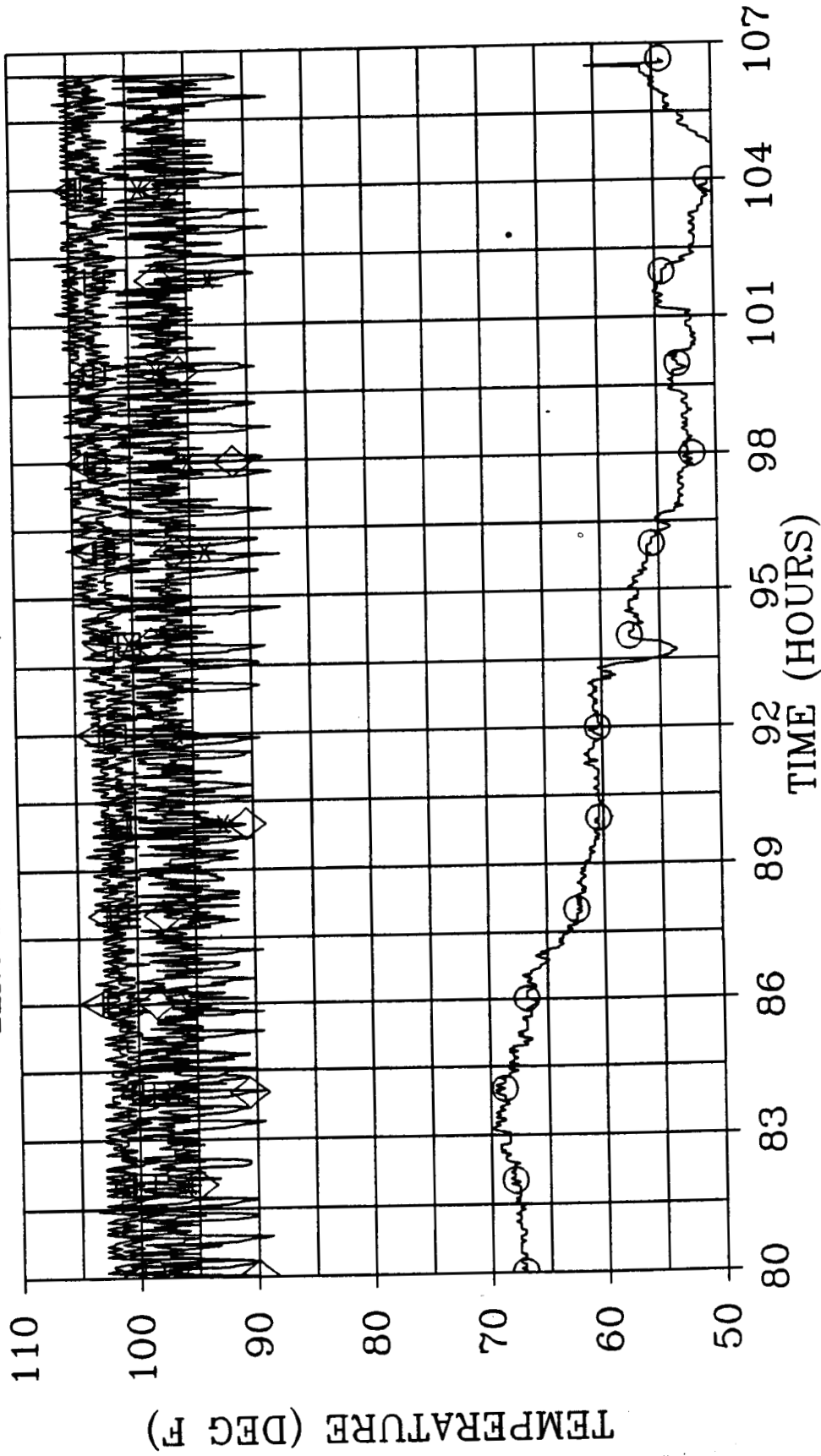
ZERO REF: 11 PM EST (KSC) 27-NOV-1988



\*NOTE: ZERO REF: 333:04:00:00 (GMT)  
 PLOTTED FROM NRT DATA (.50 SPM)  
 ALL REF INSTR BASED ON SRM ORIENTATION  
 PLOTTED 2-DEC-1988

Figure 7

# 360L002 STS-27 PRELAUNCH LEFT SRM AFT FIELD JOINT TEMPERATURE OVERLAID WITH AMBIENT ZERO REF: 11 PM EST (KSC) 27-NOV-1988



LEGEND	
—	KMTT001A (AMBIENT)
—	B06T7068A (15 DEG)
—	B06T7069A (135 DEG)
—	B06T7070A (195 DEG)
—	B06T7071A (285 DEG)

•NOTE: ZERO REF: 333:04:00:00 (GMT)  
 PLOTTED FROM NRT DATA (.50 SPM)  
 ALL REF INSTR BASED ON SRM ORIENTATION  
 PLOTTED 2-DEC-1988

Figure 8

# 360L002 STS-27 PRELAUNCH RIGHT SRM AFT FIELD JOINT TEMPERATURE OVERLAID WITH AMBIENT ZERO REF: 11 PM EST (KSC) 27-NOV-1988

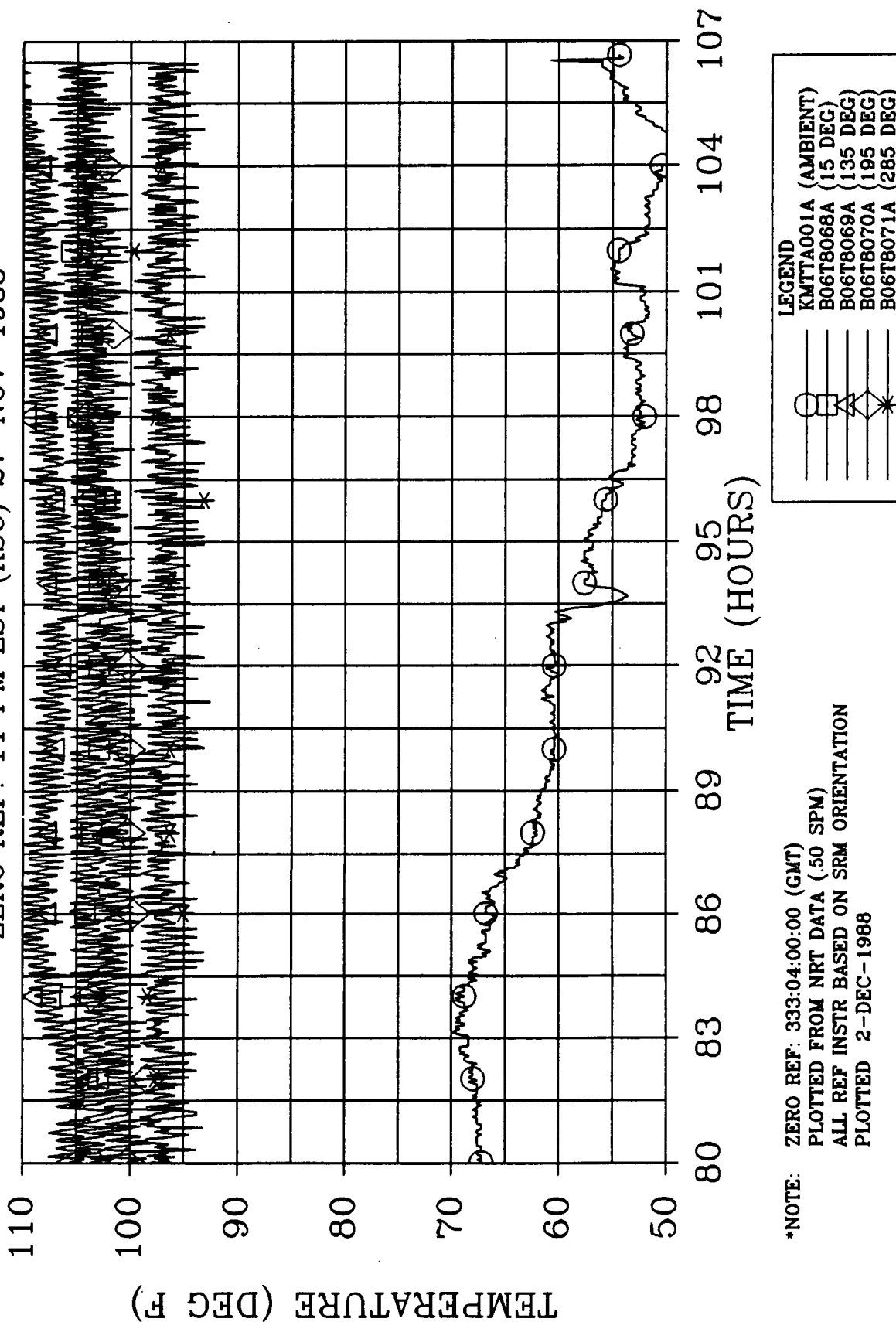
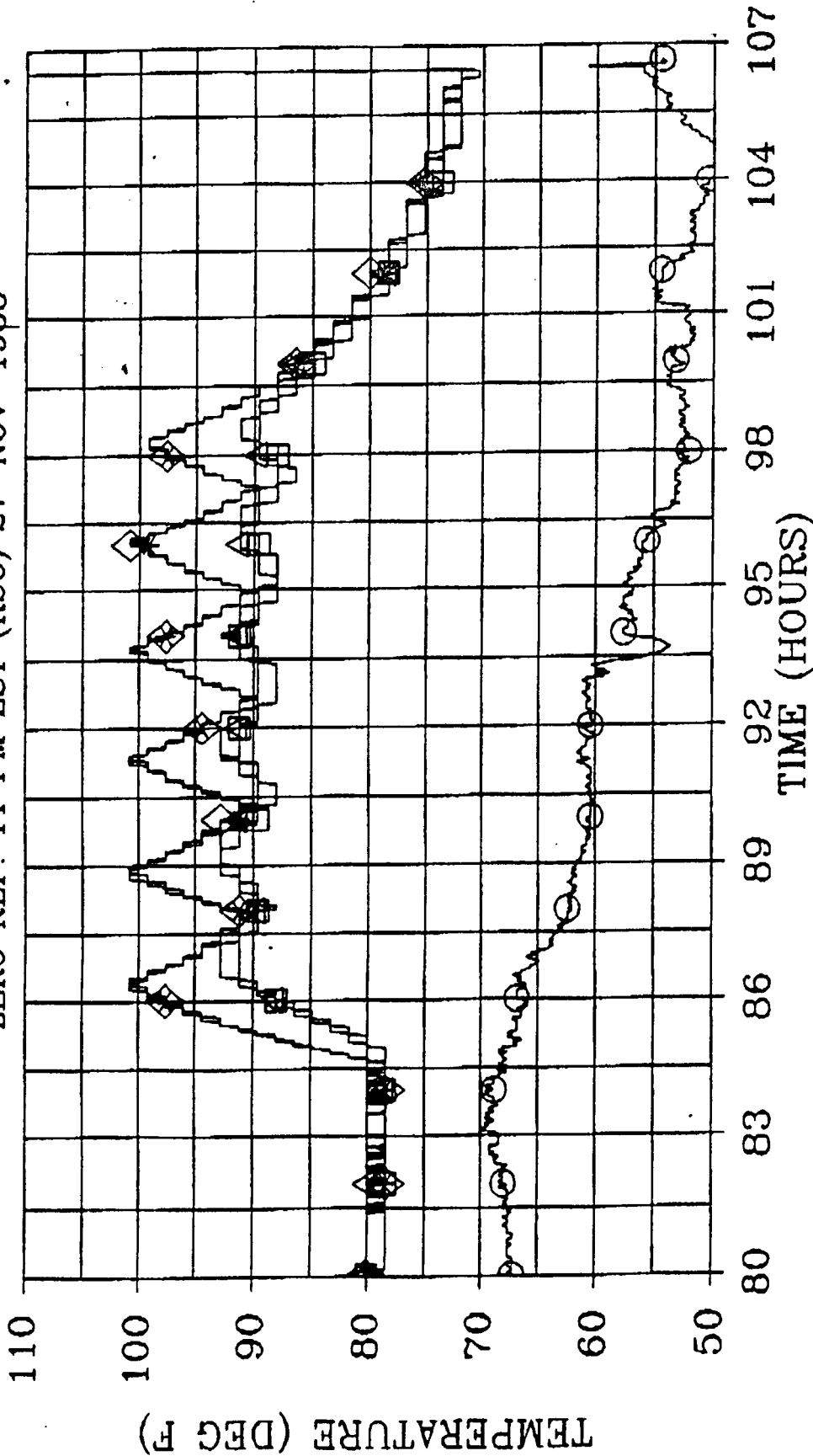


Figure 9

# 360L002 STS-27 PRELAUNCH LEFT SRM IGNITER JOINT AND S&A TEMPERATURES OVERLAID WITH AMBIENT

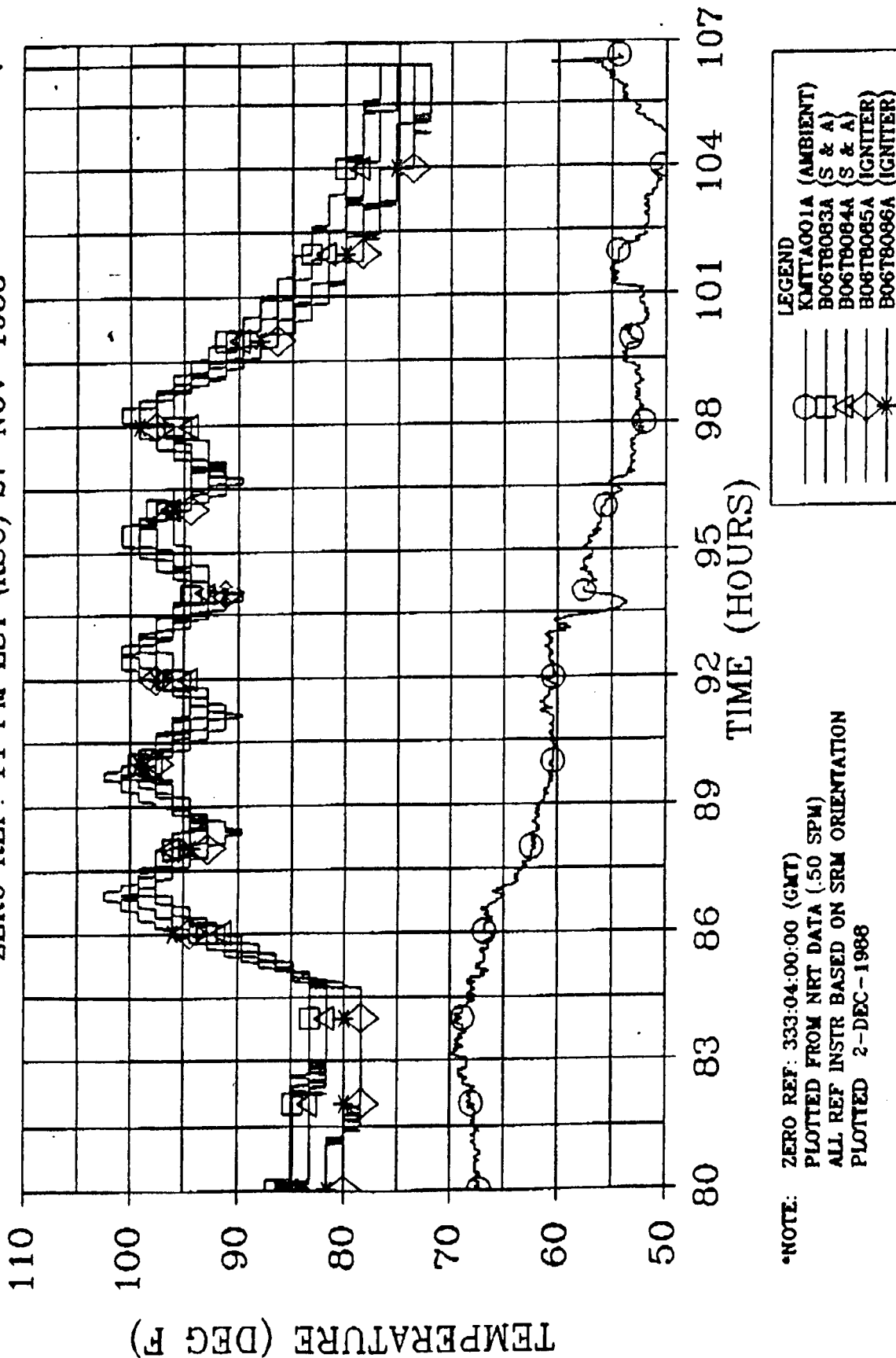
ZERO REF: 11 PM EST (KSC) 27-NOV-1988



•NOTE: ZERO REF: 333:04:00:00 (GMT)  
PLOTTED FROM NRT DATA (.50 SPM)  
ALL REF INSTR BASED ON SRM ORIENTATION  
PLOTTED 2-DEC-1988

Figure 10

# 360L002 STS-27 PRELAUNCH RIGHT SRM IGNITER JOINT AND S&A TEMPERATURES OVERLAID WITH AMBIENT ZERO REF: 11 PM EST (KSC) 27-NOV-1988



\*NOTE: ZERO REF: 333:04:00:00 (GMT)  
 PLOTTED FROM NRT DATA (.50 SPM)  
 ALL REF INSTR BASED ON SRM ORIENTATION  
 PLOTTED 2-DEC-1988

Figure 11

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**Field Joint Vent Valve and Moisture Seal - Evaluation Checkoff Worksheet (Optional)**

<b>Inspector(s):</b> CHARLES GREATWOOD/ROY HYER																			
<b>Motor No.:</b> STS-27		<b>Side:</b> <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right																	
<b>Field Joint:</b> <input checked="" type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)		<b>Date:</b> 12/5/88																	
<b>Case End:</b> Tang																			
<b>Component:</b> JPS																			
<p><b>I. Vent Valves Open to Back Pressure (VVOBP)?</b></p> <p>A. <u>45°</u> Degrees <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>B. <u>135°</u> Degrees <span style="float: right;">_____ yes <u>X</u> no</span></p> <p><b>II. Moisture Under Seal (WATER)?</b> <span style="float: right;">_____ X yes _____ no</span></p> <p>(Optional)</p> <p><b>If any of the above conditions exist, note:</b></p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Condition (Observation Code)</th> <th style="text-align: center;">Degree Location (Deg.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><u>Water</u></td> <td style="text-align: center;"><u>N/A</u></td> </tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> </tbody> </table>				Condition (Observation Code)	Degree Location (Deg.)	<u>Water</u>	<u>N/A</u>	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
Condition (Observation Code)	Degree Location (Deg.)																		
<u>Water</u>	<u>N/A</u>																		
_____	_____																		
_____	_____																		
_____	_____																		
_____	_____																		
_____	_____																		
_____	_____																		
<p><b>Notes / Comments</b></p> <p>Approximately 25 milliliters of water under moisture seal.</p>																			

TABLE 1

**Morton Thiokol Inc.**  
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**Field Joint Vent Valve and Moisture Seal - Evaluation Checkoff Worksheet (Optional)**

<b>Inspector(s):</b> CHARLES GREATWOOD/ROY HYER																
<b>Motor No.:</b> STS-27	<b>Side:</b> <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right	<b>Date:</b> 12/5/88														
<b>Field Joint:</b> <input type="checkbox"/> Forward (FWD) <input checked="" type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)	<b>Case End:</b> Tang															
<b>Component:</b> JPS																
<p><b>I. Vent Valves Open to Back Pressure (VVOBP)?</b></p> <p>A. <u>45°</u> Degrees <span style="float: right;"><u>X</u> yes <u>      </u> no</span></p> <p>B. <u>135°</u> Degrees <span style="float: right;"><u>      </u> yes <u>X</u> no</span></p> <p><b>II. Moisture Under Seal (WATER)?</b> <span style="float: right;"><u>X</u> yes <u>      </u> no</span></p> <p>(Optional)</p> <p>If any of the above conditions exist, note:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Condition (Observation Code)</th> <th style="text-align: center;">Degree Location (Deg.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><u>Water</u></td> <td style="text-align: center;"><u>N/A</u></td> </tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> </tbody> </table>			Condition (Observation Code)	Degree Location (Deg.)	<u>Water</u>	<u>N/A</u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>
Condition (Observation Code)	Degree Location (Deg.)															
<u>Water</u>	<u>N/A</u>															
<u>      </u>	<u>      </u>															
<u>      </u>	<u>      </u>															
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<u>      </u>	<u>      </u>															
<u>      </u>	<u>      </u>															
<p><b>Notes / Comments</b></p> <p>Approximately 50 milliliters of water under moisture seal.</p>																

TABLE 2

**Morton Thiokol Inc.**  
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**Field Joint Vent Valve and Moisture Seal - Evaluation Checkoff Worksheet (Optional)**

<b>Inspector(s):</b> CHARLES GREATWOOD/ROY HYER																			
<b>Motor No.:</b> STS-27		<b>Side:</b> <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right	<b>Date:</b> 12/5/88																
<b>Field Joint:</b> <input type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input checked="" type="checkbox"/> Aft (AFT)			<b>Case End:</b> Tang																
<b>Component:</b> JPS																			
<p><b>I. Vent Valves Open to Back Pressure (VVOBP)?</b></p> <p>A. <u>45°</u> Degrees <span style="float: right;"><u>X</u> yes <u>      </u> no</span></p> <p>B. <u>130°</u> Degrees <span style="float: right;"><u>X</u> yes <u>      </u> no</span></p> <p><b>II. Moisture Under Seal (WATER)?</b> <span style="float: right;"><u>X</u> yes <u>      </u> no</span></p> <p>(Optional)</p> <p><b>If any of the above conditions exist, note:</b></p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Condition (Observation Code)</th> <th style="text-align: center;">Degree Location (Deg.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><u>Water</u></td> <td style="text-align: center;"><u>N/A</u></td> </tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> </tbody> </table>				Condition (Observation Code)	Degree Location (Deg.)	<u>Water</u>	<u>N/A</u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>
Condition (Observation Code)	Degree Location (Deg.)																		
<u>Water</u>	<u>N/A</u>																		
<u>      </u>	<u>      </u>																		
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<u>      </u>	<u>      </u>																		
<p><b>Notes / Comments</b></p> <p>Approximately 900 milliliters of water under moisture seal.</p>																			

TABLE 3



Morton Thiokol Inc.  
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Field Joint Vent Valve and Moisture Seal - Evaluation Checkoff Worksheet (Optional)

Inspector(s): CHARLES GREATWOOD/ROY HYER																			
Motor No.: STS-27	Side: <input type="checkbox"/> Left	<input checked="" type="checkbox"/> Right	Date: 12/5/88																
Field Joint: <input checked="" type="checkbox"/> Forward (FWD)	<input type="checkbox"/> Center (CTR)	<input type="checkbox"/> Aft (AFT)	Case End: Tang																
Component: JPS																			
<p>I. Vent Valves Open to Back Pressure (VVOBP)?</p> <p>A. <u>45°</u> Degrees <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>B. <u>130°</u> Degrees <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>II. Moisture Under Seal (WATER)? <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>(Optional)</p> <p>If any of the above conditions exist, note:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Condition (Observation Code)</th> <th style="text-align: center;">Degree Location (Deg.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><u>Water</u></td> <td style="text-align: center;"><u>N/A</u></td> </tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> </tbody> </table>				Condition (Observation Code)	Degree Location (Deg.)	<u>Water</u>	<u>N/A</u>	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
Condition (Observation Code)	Degree Location (Deg.)																		
<u>Water</u>	<u>N/A</u>																		
_____	_____																		
_____	_____																		
_____	_____																		
_____	_____																		
_____	_____																		
_____	_____																		
<p>Notes / Comments</p> <p>Approximtely 20 milliliters of water under moisture seal.</p>																			

TABLE 4

**Morton Thiokol Inc.**  
**Space Operations**

**Field Joint Vent Valve and Moisture Seal - Evaluation Checkoff Worksheet (Optional)**

<b>Inspector(s):</b> CHARLES GREATWOOD/ROY HYER																	
<b>Motor No.:</b> STS-27	<b>Side:</b> <input type="checkbox"/> Left <input checked="" type="checkbox"/> Right		<b>Date:</b> 12/5/88														
<b>Field Joint:</b> <input type="checkbox"/> Forward (FWD) <input checked="" type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)	<b>Case End:</b> Tang																
<b>Component:</b> JPS																	
<p><b>I. Vent Valves Open to Back Pressure (VVOBP)?</b></p> <p>A. <u>45°</u> Degrees <span style="float: right;"><u>      </u> yes <u>      </u> <u>X</u> no</span></p> <p>B. <u>135°</u> Degrees <span style="float: right;"><u>      </u> yes <u>      </u> <u>X</u> no</span></p> <p><b>II. Moisture Under Seal (WATER)?</b> <span style="float: right;"><u>X</u> yes <u>      </u> no</span></p> <p>(Optional)</p> <p>If any of the above conditions exist, note:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Condition (Observation Code)</th> <th style="text-align: center;">Degree Location (Deg.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><u>Water</u></td> <td style="text-align: center;"><u>N/A</u></td> </tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> <tr><td style="text-align: center;"><u>      </u></td><td style="text-align: center;"><u>      </u></td></tr> </tbody> </table>				Condition (Observation Code)	Degree Location (Deg.)	<u>Water</u>	<u>N/A</u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>	<u>      </u>
Condition (Observation Code)	Degree Location (Deg.)																
<u>Water</u>	<u>N/A</u>																
<u>      </u>	<u>      </u>																
<u>      </u>	<u>      </u>																
<u>      </u>	<u>      </u>																
<u>      </u>	<u>      </u>																
<u>      </u>	<u>      </u>																
<p><b>Notes / Comments</b></p> <p>Approximately 20 milliliters of water under moisture seal.</p>																	

TABLE 5

**Morton Thiokol Inc.**  
**Space Operations**

**Field Joint Vent Valve and Moisture Seal - Evaluation Checkoff Worksheet (Optional)**

Inspector(s): CHARLES GREATWOOD/ROY HYER																	
Motor No.: STS-27		Side: <input type="checkbox"/> Left <input checked="" type="checkbox"/> Right	Date: 12/5/88														
Field Joint: <input type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input checked="" type="checkbox"/> Aft (AFT)		Case End: Tang															
Component: JPS																	
<p>I. Vent Valves Open to Back Pressure (VVOBP)?</p> <p>A. <u>45°</u> Degrees <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>B. <u>135°</u> Degrees <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>II. Moisture Under Seal (WATER)? <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>(Optional)</p> <p>If any of the above conditions exist, note:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Condition (Observation Code)</th> <th style="text-align: center;">Degree Location (Deg.)</th> </tr> </thead> <tbody> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td></tr> </tbody> </table>				Condition (Observation Code)	Degree Location (Deg.)	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
Condition (Observation Code)	Degree Location (Deg.)																
_____	_____																
_____	_____																
_____	_____																
_____	_____																
_____	_____																
_____	_____																
Notes / Comments																	

TABLE 6

## Space Operations

## Field Joint External Insulation Condition - Evaluation Checkoff Worksheet

Inspector(s): CHARLES GREATWOOD/ROY HYER/NEDRA HUNDLEY						
Motor No.: STS-27			Side: <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right		Date: 12/5/88	
Field Joint: <input checked="" type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)						
Component: JPS						
I. External Cork Insulation						
A. Voids or Missing Material >0.7 cu.in. (TPSVD)?			_____ yes	<u>  X  </u> no		
B. Debonds (DEBND)?			_____ yes	<u>  X  </u> no		
C. Charred Material (HTAFF)?			_____ yes	<u>  X  </u> no		
If any of the above conditions exist, note:						
Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	Radial Depth (In.)
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Notes / Comments						
Numerous nicks on aft end of JPS cork insulation. Slight blistering of hypalon paint in several locations. Overall cork and K5NA in excellent condition.						

TABLE 7

**Morton Thiokol Inc.**  
Space Operations

Field Joint External Insulation Condition - Evaluation Checkoff Worksheet

Inspector(s): CHARLES GREATWOOD/ROY HYER/NEDRA HUNDLEY		
Motor No.:	Side: <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right	Date: 12/5/88
Field Joint: <input type="checkbox"/> Forward (FWD) <input checked="" type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)		
Component: JPS		

I. External Cork Insulation

A. Voids or Missing Material >0.7 cu.in. (TPSVD)?	yes	no	<u>X</u>	no
B. Debonds (DEBND)?	yes	no	<u>X</u>	no
C. Charred Material (HTAFF)?	yes	no	<u>X</u>	no

If any of the above conditions exist, note:

Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	Radial Depth (In.)

Notes / Comments

Numerous nicks on aft end of JPS cork insulation usually .25 in<sup>2</sup> or smaller. Slight blistering of hypalon paint in several areas. Overall cork and K5NA in excellent condition.

TABLE 8

## Space Operations

### Field Joint External Insulation Condition - Evaluation Checkoff Worksheet

Inspector(s): CHARLES GREATWOOD/ROY HYER/NEDRA HUNDLEY						
Motor No.: STS-27			Side: <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right		Date: 12/5/88	
Field Joint: <input type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input checked="" type="checkbox"/> Aft (AFT)						
Component: JPS						
<p>I. External Cork Insulation</p> <p>A. Voids or Missing Material &gt;0.7 cu.in. (TPSVD)? <span style="float: right;">_____ yes <u>      </u> X no</span></p> <p>B. Debonds (DEBND)? <span style="float: right;">_____ yes <u>      </u> X no</span></p> <p>C. Charred Material (HTAFF)? <span style="float: right;">_____ yes <u>      </u> X no</span></p> <p>If any of the above conditions exist, note:</p>						
Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	Radial Depth (In.)
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

**Notes / Comments**

Cork and K5NA in excellent condition. Slight blistering of hypalon paint in several areas.

TABLE 9

## Space Operations

### Field Joint External Insulation Condition - Evaluation Checkoff Worksheet

Inspector(s): CHARLES GREATWOOD/ROY HYER						
Motor No.: STS-27			Side: <input type="checkbox"/> Left <input checked="" type="checkbox"/> Right		Date: 12/5/88	
Field Joint: <input checked="" type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)						
Component: JPS						
I. External Cork Insulation						
A. Voids or Missing Material >0.7 cu.in. (TPSVD)?			_____	yes	<u>  X  </u>	no
B. Debonds (DEBND)?			_____	yes	<u>  X  </u>	no
C. Charred Material (HTAFF)?			_____	yes	<u>  X  </u>	no
If any of the above conditions exist, note:						
Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	Radial Depth (In.)
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
<b>Notes / Comments</b>						
Numerous nicks on aft end of JPS cork insulation usually .25 in <sup>2</sup> or smaller. Slight blistering of hypalon paint in several locations. Overall cork and K5NA is in excellent condition.						

TABLE 10

## Space Operations

### Field Joint External Insulation Condition - Evaluation Checkoff Worksheet

Inspector(s): CHARLES GREATWOOD/ROY HYER						
Motor No.: STS-27		Side: <input type="checkbox"/> Left <input checked="" type="checkbox"/> Right		Date: 12/5/88		
Field Joint: <input type="checkbox"/> Forward (FWD) <input checked="" type="checkbox"/> Center (CTR) <input type="checkbox"/> Aft (AFT)						
Component: JPS						
<p>I. External Cork Insulation</p> <p>A. Voids or Missing Material &gt;0.7 cu.in. (TPSVD)?      <u>  X  </u> yes      <u>      </u> no</p> <p>B. Debonds (DEBND)?      <u>      </u> yes      <u>  X  </u> no</p> <p>C. Charred Material (HTAFF)?      <u>      </u> yes      <u>  X  </u> no</p>						
If any of the above conditions exist, note:						
Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	Radial Depth (In.)
<b>Notes / Comments</b> Cork piece approximately 3.0 x 3.0 inch missing. Air gap unbond between cork and adhesive over moisture seal approximately .150 inch in area around missing cork. Numerous nicks on aft end of JPS cork insulation usually .25 in <sup>2</sup> or smaller. Partial blistering of hypalon paint in several areas.						

TABLE 11



## Space Operations

## Field Joint External Insulation Condition - Evaluation Checkoff Worksheet

Inspector(s): CHARLES GREATWOOD/ROY HYER						
Motor No.: STS-27			Side: <input type="checkbox"/> Left <input checked="" type="checkbox"/> Right		Date: 12/5/88	
Field Joint: <input type="checkbox"/> Forward (FWD) <input type="checkbox"/> Center (CTR) <input checked="" type="checkbox"/> Aft (AFT)						
Component: JPS						
I. External Cork Insulation						
A. Voids or Missing Material >0.7 cu.in. (TPSVD)?			_____ yes	_____ <u>X</u> no		
B. Debonds (DEBND)?			_____ yes	_____ <u>X</u> no		
C. Charred Material (HTAFF)?			_____ yes	_____ <u>X</u> no		
If any of the above conditions exist, note:						
Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	Radial Depth (In.)
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Notes / Comments						
Cork and K5NA in excellent condition. Slight blistering of hypalon paint in several locations.						

TABLE 12

**Morton Thiokol Inc.**  
Space Operations

**Field Joint Heater Cable Condition - Evaluation Checkoff Worksheet**

Inspector(s): CHARLES GREATWOOD/ROY HYER																																																							
Motor No.: STS-27			Side: <input checked="" type="checkbox"/> Left (A) <input type="checkbox"/> Right (B)		Date: 12/5/88																																																		
Inspection Location: <input type="checkbox"/> Prior to Lifting Strap Installation <input checked="" type="checkbox"/> After Ocean Removal																																																							
Component: TPS																																																							
<p>I. External Cork Insulation</p> <p>A. Voids or Missing Material (TPSVD)? <span style="float: right;">_____ yes <u>  X  </u> no</span></p> <p>B. Debonds (DEBND)? <span style="float: right;">_____ yes <u>  X  </u> no</span></p> <p>C. Charred (HTAFF)? <span style="float: right;">_____ yes <u>  X  </u> no</span></p> <p>D. Impact Damage (TPSDM)? <span style="float: right;">_____ yes <u>  X  </u> no</span></p> <p>II. Cables Debonded (DEBND)? <span style="float: right;">_____ yes <u>  X  </u> no</span></p> <p>If any of the above conditions exist, note:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 15%;">Segment (FWD, FCS, ACS or AFT)</th> <th style="width: 15%;">Condition (Observation Code)</th> <th style="width: 15%;">Axial Location (Station) (In.)</th> <th style="width: 15%;">Starting Degree Location (Deg.)</th> <th style="width: 15%;">Ending Degree Location (Deg.)</th> <th style="width: 15%;">Circumferential Width (In.)</th> <th style="width: 15%;">Axial Length (In.)</th> </tr> </thead> <tbody> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> </tbody> </table>							Segment (FWD, FCS, ACS or AFT)	Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
Segment (FWD, FCS, ACS or AFT)	Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)																																																	
_____	_____	_____	_____	_____	_____	_____																																																	
_____	_____	_____	_____	_____	_____	_____																																																	
_____	_____	_____	_____	_____	_____	_____																																																	
_____	_____	_____	_____	_____	_____	_____																																																	
_____	_____	_____	_____	_____	_____	_____																																																	
_____	_____	_____	_____	_____	_____	_____																																																	
<p><b>Notes / Comments</b></p> <p>JPS cable cork and K5NA in excellent condition. Slight blistering of hypalon paint in several locations</p>																																																							

**Morton Thiokol Inc.**  
Space Operations

**Field Joint Heater Cable Condition - Evaluation Checkoff Worksheet**

Inspector(s): CHARLES GREATWOOD/ROY HYER						
Motor No.: STS-27			Side: <input type="checkbox"/> Left (A) <input checked="" type="checkbox"/> Right (B)		Date: 12/5/88	
Inspection Location: <input type="checkbox"/> Prior to Lifting Strap Installation <input checked="" type="checkbox"/> After Ocean Removal						
Component: TPS						
<p>I. External Cork Insulation</p> <p>A. Voids or Missing Material (TPSVD)? <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>B. Debonds (DEBND)? <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>C. Charred (HTAFF)? <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>D. Impact Damage (TPSDM)? <span style="float: right;">_____ yes <u>X</u> no</span></p> <p>II. Cables Debonded (DEBND)? <span style="float: right;">_____ yes <u>X</u> no</span></p>						
If any of the above conditions exist, note:						
Segment (FWD, FCS, ACS or AFT)	Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
<p><b>Notes / Comments</b></p> <p>All JPS cable TPS in excellent condition, cork and K5NA. Looks like it hasn't flown.</p>						

TABLE 14

REV. \_\_\_\_\_

**Morton Thiokol Inc.**  
Space Operations

**Igniter Heater Installation Condition - Evaluation Checkoff Worksheet**

Inspector(s): CHARLES GREATWOOD/BILL McPEAK/JIM McEVEN					
Motor No.: STS-27		Side: <input type="checkbox"/> Left (A) <input checked="" type="checkbox"/> Right (B)		Date: 12/5/88	
Joint: Igniter (IGN)		Case End: Igniter Adapter (FWD)		Component: JPS	

I.	Igniter Heater				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		
II.	Cork Insulation				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		
III.	T-Bolt Latch Band Clamp				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		
IV.	Igniter Heater Power Cables				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		

If any of the above conditions exist, note:

Affected Part (I, II, III or IV)	Condition (Observation Code)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

**Notes / Comments**

Igniter heater installation is secure and in proper position.

**Morton Thiokol Inc.**  
Space Operations

**Igniter Heater Installation Condition - Evaluation Checkoff Worksheet**

Inspector(s): CHARLES GREATWOOD/BILL McPEAK/JIM McEVEN					
Motor No.: STS-27			Side: <input checked="" type="checkbox"/> Left (A) <input type="checkbox"/> Right (B)		Date: 12/5/88
Joint: Igniter (IGN)		Case End: Igniter Adapter (FWD)		Component: JPS	

I.	Igniter Heater				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		
II.	Cork Insulation				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		
III.	T-Bolt Latch Band Clamp				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		
IV.	Igniter Heater Power Cables				
	A. Unsecure(LOOSE)?	_____ yes	<u>  X  </u> no		
	B. Improper position (DISCP)?	_____ yes	<u>  X  </u> no		

If any of the above conditions exist, note:

Affected Part (I, II, III or IV)	Condition (Observation Code)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

**Notes / Comments**

Igniter heater installation is secure and in proper position.

TABLE 16

**Morton Thiokol Inc.**  
**Space Operations**

**Igniter Heater Component - Evaluation Checkoff Worksheet**

<b>Inspector(s):</b> CHARLES GREATWOOD/BILL McPEAK/JIM McEVEN						
<b>Motor No.:</b> STS-27			<b>Side:</b> <input type="checkbox"/> Left <input checked="" type="checkbox"/> Right		<b>Date:</b> 12/5/88	
<b>Joint:</b> Igniter (IGN)		<b>Case End:</b> Igniter Adapter (FWD)			<b>Component:</b> JPS	

I. T-Bolt Latch Band Clamp Assembly Intact (BAND)?	_____ yes	_____X_____ no	
II. Igniter Heater			
A. Delaminations (DLHTR)?	_____ yes	_____X_____ no	
B. Discolorations (DSCLR)?	_____X_____ yes	_____ no	
C. Charred (HTAFF)?	_____X_____ yes	_____ no	
D. Warped (HTAFF)?	_____X_____ yes	_____ no	
III. Heater Power Cables			
A. Not Intact (LOOSE)?	_____ yes	_____X_____ no	
B. Charred (HTAFF)?	_____ yes	_____X_____ no	

If any of the above conditions exist, note:

Affected Part (I, II or III)	Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)

**Notes / Comments**

Heater charred and warped starting 38 inches from heater wire lead egress end and extending for 7.5 inches.

TABLE 17

**Morton Thiokol Inc.**  
Space Operations

**Igniter Heater Component - Evaluation Checkoff Worksheet**

Inspector(s): CHARLES GREATWOOD/BILL McPEAK/JIM McEVEN		
Motor No.:	Side: <input checked="" type="checkbox"/> Left <input type="checkbox"/> Right	Date: 12/5/88
Joint: Igniter (IGN)	Case End: Igniter Adapter (FWD)	Component: JPS

- |  |     |     |    |
|--|-----|-----|----|
| I. T-Bolt Latch Band Clamp Assembly Intact (BAND)? | yes | X   | no |
| II. Igniter Heater                                 |     |     |    |
| A. Delaminations (DLHTR)?                          | yes | X   | no |
| B. Discolorations (DSCLR)?                         | X   | yes | no |
| C. Charred (HTAFF)?                                | X   | yes | no |
| D. Warped (HTAFF)?                                 | X   | yes | no |
| III. Heater Power Cables                           |     |     |    |
| A. Not Intact (LOOSE)?                             | yes | X   | no |
| B. Charred (HTAFF)?                                | yes | X   | no |

If any of the above conditions exist, note:

Affected Part (I, II or III)	Condition (Observation Code)	Axial Location (Station) (In.)	Starting Degree Location (Deg.)	Ending Degree Location (Deg.)	Circumferential Width (In.)	Axial Length (In.)

**Notes / Comments**

Heater charred and warped in 3 places.

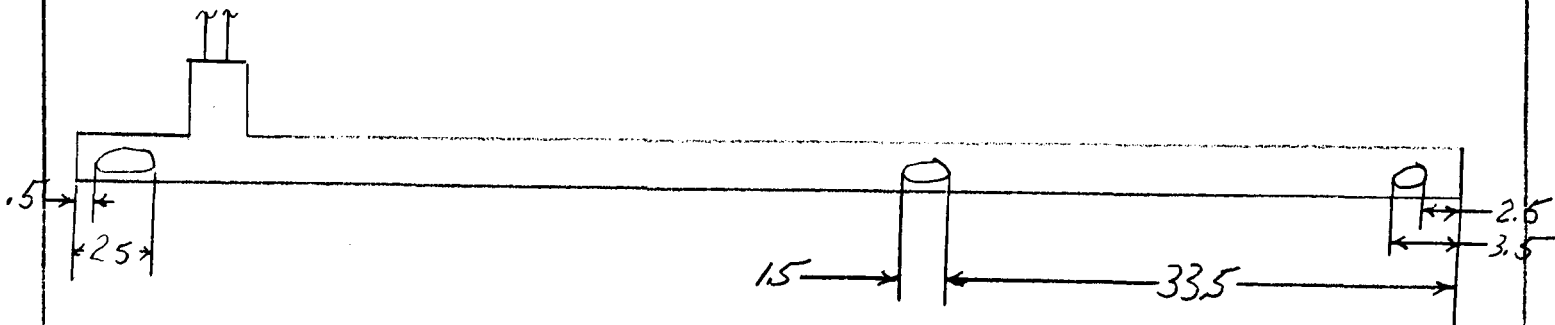


TABLE 18

REV. \_\_\_\_\_

MORTON THIOKOL INC.

Aerospace Group

Space Operations

DISTRIBUTION

	MS
E. HALE	L23B
J. OOSTYEN	L23B
R. WILKS	L23
J. SEILER	L10
R. LARSEN	851
T. OLSEN	L31
R. ADARES	851
T. MORGAN	L10
S. OLSON	L35
C. WHITWORTH	L40

REVISION \_\_\_\_\_

FORM TC 7994-310 (REV 2-88)

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